RTCA Special Committee 209

ATCRBS / Mode S Transponder

Meeting #2

L-3 / The Titan Group, Mays Landing NJ
23 – 24 May 2006

Proposed Changes to Test Procedures
In RTCA-DO-181C
Rev 1 - As annotated and revised during Meeting #2
Rev 2 – As annotated and revised during Meeting #3

John Van Dongen
WJH FAA Technical Center

SUMMARY

This working paper contains proposed changes to test procedures contained in sections 2.3 and 2.4 of the Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment (DO-181C). The proposed changes are to correct errors, improve test procedures, or to provide clarity.

RTCA-DO181C Test Procedures

This working paper contains proposed changes to test procedures contained in sections 2.3 and 2.4 of the Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment (DO-181C). The proposed changes are to correct errors, improve test procedures, or to provide clarity.

The format of the working paper is for each change item to include a paragraph briefly explaining the reason for the proposed change followed by an excerpt of the MOPS text highlighting the change.

Low-Level Reply Ratio

There are four test procedures to measure the "Low-Level Reply Ratio" contained in sections 2.3.2.1 and 2.4.2.1. These tests call for measuring the reply efficiency with an RF input signal level equal to -81.0 dBm. However, the specification (2.2.2.4.d) states that "The reply ratio shall not be more than 10 percent for interrogations at signal levels below -81 dBm." There is no specific requirement for signals equal to -81 dBm. The test procedures should use a signal level below -81 dBm. [THIS CHANGE WAS REJECTED BY SC-209 AFTER DISCUSSION ON -81 VERSUS -82]

2.3.2.1 Receiver Characteristics (Paragraph 2.2.2)

…

Step 4 ATCRBS/Mode S All/Call Low-Level Reply Ratio (Subparagraph 2.2.2.4.d)

Interrogate the transponder with a standard Mode C ATCRBS/Mode S All-Call at an RF level of -~~81~~82.0 dBm. Determine reply ratio.

…

Step 7 Mode S Low-Level Reply Ratio (Subparagraph 2.2.2.4.d)

Using the signal specified in Step 5, determine reply efficiency for an RF level of -~~81~~ 82 dBm.

2.4.2.1 Receiver Characteristics (Paragraph 2.2.2)

…

Step 5 ATCRBS and ATCRBS/Mode S All-Call Low-Level Reply Ratio (Subparagraph 2.2.2.4.d)

Repeat Step 2 for an RF level of -~~81~~82.0 dBm. Determine reply ratio.

…

Step 8 Mode S Low-Level Reply Ratio (Subparagraph 2.2.2.4.d)

Using the signal specified in Step 6, determine reply efficiency for an RF level of -~~81~~ 82 dBm.

==========

Reply Transmission Frequency

In test procedure 2.4.2.2.1 Reply Transmission Frequency, when adjusting for the maximum frequency shift, it is possible for equipment under test to have the extremes of the frequency shift on the same side of 1090 MHz. The test procedure is changed below to reflect this possibility.

2.4.2.2.1 Reply Transmission Frequency (Subparagraph 2.2.3.1)

…

Measurement Procedure

Connect the equipment as shown in figure 2-25. Adjust the stub to establish a 1.5:1 VSWR at the antenna end of the coax line specified by the manufacturer. If the transponder requires a minimum length of a specified cable type, an attenuator equal to the loss of the minimum amount of cable may be placed between the 1.5:1 VSWR point and the transponder antenna jack. Alternately, a length of cable equal to the specified minimum length and cable type may be used in lieu of the attenuator. Interrogate the transponder with a standard Mode A interrogation and adjust the line stretcher ~~for~~ to determine the maximum and minimum transmitter frequency ~~shift above and below 1090 MHz~~. Use a 14 (7777) pulse reply group. Repeat the above procedure with a standard Mode A ATCRBS/Mode S All-Call at standard rate only. Determine that the frequency shift does not exceed the requirements of subparagraph 2.2.3.1.

==========

RF Peak Power Output

The RF Peak Power Output requirement sets minimum power requirements for all reply pulses. Because of the potential for transmitter droop, the RF Power Output of pulses at the end of a transmission may be at the lowest amplitude of the transmission. Therefore, the test procedures should use a long Mode S reply format where applicable. The Test procedures below contain suggested changes.

2.3.2.2.2 RF Peak Power Output (Subparagraph 2.2.3.2)

…[THIS WILL BE REVISED AND RESUBMITTED AT THE NEXT MEETING]

Step 2 Mode S Power Output (Subparagraph 2.2.3.2)

Repeat Step 1 with a standard Mode A ATCRBS/Mode S All-Call interrogation at the standard rate. If the transponder is equipped for long Mode S reply formats, use a Mode S interrogation that requires a long reply.

2.4.2.2.2 RF Peak Power Output (Subparagraph 2.2.3.2)

…

Step 2 Mode S Power Output (Subparagraph 2.2.3.2)

Repeat Step 1 with a standard Mode A ATCRBS/Mode S All-Call interrogation at the standard rate only. If the transponder is equipped for long Mode S reply formats, use a Mode S interrogation that requires a long reply.

==========

Unwanted Power Output

The Unwanted Power Output Test looks incomplete. Suggested additional text is shown below.

2.4.2.2.3 Unwanted Power Output (Subparagraph 2.2.3.3 and paragraph 2.2.20 f)

…

Measurement Procedure

Connect the equipment as shown in Figure 2-32. Do not interrogate the transponder. ~~With the transponder on, but with squitters disabled, m~~Measure the RF output power between squitter transmission periods.

==========

Reply Rate Capability

There are multiple proposed changes to the Reply Rate Capability test procedures. (1) Steps 1 and 2 of 2.3.2.2.3 are basically the same test and should be combined (the title of step 2 is more accurate). (2) Some test steps have incorrect reference to the requirements section being tested and are corrected. (3) Some of the test steps in 2.3.2.2.3 and 2.4.2.2.4 call for measuring the output power and frequency as a function of the test, but others do not. Since these tests subject the equipment under test to high transmission rates, it is suggested that these measurements be consistently included in each step. (4) Some of the test steps in 2.3.2.2.3 and 2.4.2.2.4 call for measuring the reply ratio, others do not. Since this is the fundamental requirement being tested, this has been included in each step. (5) There is an inconsistency in the text by calling for either a 15-pulse ATCRBS reply, or a 14-pulse ATCRBS reply with SPI-pulse. The latter was chosen for clarity and consistency. (6) The requirements for reply rate capability are different for equipment intended for installation in aircraft that will operate below 15,000 feet than for equipment intended for altitudes above. The test procedures are modified to accommodate these differences. (7) The requirements in 2.2.3.4.1 b and c are not clear as stated. It could be interpreted incorrectly as meaning that the transponder is required to reply to 1,200 ATCRBS interrogations in 100 milliseconds (in b, 1,000 in c). It is believed that this is a per second rate, therefore the transponder is required to reply to 120 ATCRBS interrogations in 100 milliseconds. The following text includes the sum of

these proposed changes. [THIS WILL BE UPDATED USING EQUIPMENT LEVELS TEXT AND RESUBMITTED AT THE NEXT MEETING]

2.3.2.2.3 Reply Rate Capability

~~Step 1 ATCRBS Reply Rate Capability (Subparagraphs 2.2.3.4.1 a and b)~~

~~Set the transponder for a 15-pulse ATCRBS reply. Interrogate the transponder at a constant rate of 500 ATCRBS interrogations per second plus 50 Mode S interrogations (with short replies) per second. Measure the output power and frequency. If the transponder is equipped for long Mode S reply formats, repeat the test with 16 (24 if also equipped with the enhanced data link protocols) of the 50 Mode S interrogations requiring long replies.~~

Step ~~2~~1 Continuous Reply Rate Capability (Subparagraphs 2.2.3.4.1 ~~e~~a and 2.2.3.4.2)

Set the transponder for a 14 pulse plus SPI-pulse ATCRBS reply. Interrogate the transponder at a constant rate of 500 ATCRBS interrogations per second plus 50 Mode S interrogations (with short replies) per second. If the transponder is equipped for long Mode S reply formats, have 16 (24 if also equipped with the enhanced data link protocols) of the 50 Mode S interrogations requiring long replies. Determine reply ratio for each type of interrogation. Measure the output power and frequency.

Step ~~2~~3 100 Milliseconds Peak Reply Rate Capability (Subparagraphs 2.2.3.4.1 b and c, and 2.2.3.4.2)

Set the transponder for a 14 pulse plus SPI-pulse ATCRBS reply. Interrogate the transponder with periodic bursts of ATCRBS and Mode S interrogations as follows: 120 ATCRBS interrogations (100 if the equipment is intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet) plus 18 Mode S interrogations (with short replies), each type of interrogation approximately uniformly spaced within a single 0.1 second interval, followed by a 0.9-second interval with no interrogations. If the transponder is equipped for long Mode S reply formats, have 6 (9 if also equipped with the enhanced data link protocols) of the 18 Mode S interrogations requiring long replies. Determine reply ratio for each type of interrogation. Measure the output power and frequency.

Step ~~3~~4 25 Milliseconds Peak Reply Rate Capability (Subparagraph~~s 2.2.3.4.1 b and c, and~~ 2.2.3.4.2)

Set the transponder for a 14 pulse plus SPI-pulse ATCRBS reply. Interrogate the transponder with periodic bursts of ATCRBS and Mode S interrogations as follows: 30 ATCRBS interrogations (25 if the equipment is intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet) plus 8 Mode S interrogations (requiring short replies), each type of interrogation burst approximately uniformly spaced within a single 25-millisecond interval, followed by a 975-millisecond interval with no interrogations. If the transponder is equipped for long Mode S reply formats, have 4 (6 if also equipped with the enhanced data link protocols) of the 8 Mode S interrogations requiring long replies. Determine reply ratio for each type of interrogation. Measure the output power and frequency.

Step ~~4~~5 1.6 Milliseconds Peak Reply Rate Capability (Subparagraphs 2.2.3.4.1 and 2.2.3.4.2)

Repeat Step 3 with the following modification: Use two ATCRBS interrogations plus four Mode S interrogations (with short replies), each type of interrogation approximately uniformly spaced within a single 1.6-millisecond interval, followed by a 998.4-millsecond interval with no interrogation. If the transponder is so equipped, two of the Mode S interrogations require long replies instead of all short replies. Determine reply ratio for each type of interrogation. Measure the output power and frequency.

2.4.2.2.4 Reply Rate Capability

Equipment Required

Mode S Transponder Test Set.

Measurement Procedure

Step 1 Continuous Reply Rate Capability (Subparagraphs 2.2.3.4.1 ~~c~~ a and 2.2.3.4.2)

Set the transponder for a ~~15~~14-pulse plus SPI-pulse ATCRBS reply. Interrogate the transponder at a constant rate of 500 ATCRBS interrogations per second plus 50 Mode S interrogations (with short replies) per second. ~~Measure the output power and frequency.~~ If the transponder is equipped for long Mode S reply formats, ~~repeat the test with~~have 16 (24 if also equipped with the enhanced data link protocols) of the 50 Mode S interrogations requiring long replies. Determine reply ratio for each type of interrogation. Measure the output power and frequency.

Step 2 100 Milliseconds Peak Reply Rate Capability (Subparagraphs 2.2.3.4.1 b and c, and 2.2.3.4.2)

Set the transponder for a ~~15~~14-pulse plus SPI-pulse ATCRBS reply. Interrogate the transponder with periodic bursts of ATCRBS and Mode S interrogations as follows: 120 ATCRBS interrogations (100 if the equipment is intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet) plus 18 Mode S interrogations (with short replies), each type of interrogation approximately uniformly spaced within a single 0.1 second interval, followed by a 0.9-second interval with no interrogations. ~~Measure the output power and frequency.~~ If the transponder is equipped for long Mode S reply formats, have ~~repeat the test with~~ 6 (9 if also equipped with the enhanced data link protocols) of the 18 Mode S interrogations requiring long replies. Determine reply ratio for each type of interrogation. Measure the output power and frequency.

Step 3 25 Milliseconds Peak Reply Rate Capability (Subparagraph~~s 2.2.3.4.1 b an c, and~~ 2.2.3.4.2)

Set the transponder for a 14~~15~~-pulse plus SPI-pulse ATCRBS reply. Interrogate the transponder with periodic bursts of ATCRBS and Mode S interrogations as follows: 30 ATCRBS interrogations (25 if the equipment is intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet) plus eight Mode S interrogations (requiring short replies), each type of interrogation burst approximately uniformly spaced within a single 25-millisecond interval, followed by a 975-millisecond interval without interrogations. ~~Measure output power and frequency.~~ If the transponder is equipped for long Mode S reply formats, have~~repeat the test with~~ 4 (6 if also equipped with the enhanced data link protocols) of the 8 Mode S interrogations requiring long replies.

Determine reply ratio for each type of interrogation. Measure output power and frequency.

Step 4 1.6 Milliseconds Peak Reply Rate Capability (Subparagraphs 2.2.3.4.1 and 2.2.3.4.2)

Repeat Step 3~~2~~ with the following modification:

Use two ATCRBS interrogations plus four Mode S interrogations (with short replies), each type of interrogation approximately uniformly spaced within a single 1.6-millisecond interval, followed by a 998.4-millsecond interval with no interrogation. ~~Measure output power and frequency.~~ If the transponder is so equipped have~~repeat the test with~~ two of the four Mode S interrogations require~~having~~ long replies. Determine reply ratio for each type of interrogation. Measure output power and frequency.

The following is the related suggested change to the requirements section.

2.2.3.4.1 ATCRBS Reply Rate Capability

…

b. If intended for installation in aircraft that operate at altitudes above 15,000 feet, the transponder shall be capable of a peak reply rate of 1,200 ATCRBS 15-pulse replies per second for a duration of 100 milliseconds.

c. If intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet, the transponder shall be capable of a peak reply rate of 1,000 ATCRBS 15-pulse replies per second for a duration of 100 milliseconds.

==========

ATCRBS Reply Pulse Characteristics

The requirements for the SPI pulse in 2.2.4.1 include requirements for the SPI pulse position, duration, and the time that the pulse is in the reply. It is also required that the SPI pulse is not included in ATCRBS Mode C replies. Currently the test procedure in 2.4.2.3.3 is set up to measure the SPI pulse position and the time it remains in the reply. The SPI test should be expanded to include verification of the width of the SPI pulse, and verify that it is not present in Mode C replies.

2.4.2.3.1 ATCRBS Reply Pulse Characteristics (Subparagraph 2.2.4.1)

…

Step 3 SPI Pulse (Subparagraphs 2.2.4.1.3, 2.2.4.1.4 and 2.2.4.1.5)

Momentarily activate the SPI pulse control. Interrogate the transponder with a standard ATCRBS Mode-A interrogation. Measure the position of the SPI pulse with respect to the last framing pulse and the time the pulse remains in the reply train. Measure the width of the SPI pulse. With the SPI pulse activated, interrogate the transponder with a standard ATCRBS Mode-C interrogation. Verify that the SPI pulse is not present in the reply train.

==========

Mode S Replies

The Mode S Replies test section contains redundant tests.

2.4.2.3.3 Mode S Replies (Subparagraph 2.2.4.2)

…

Step 4 Mode S Reply Pulse Shape (Subparagraph 2.2.4.2.3 b)

Measure the rise ~~and decay~~ time of the reply pulses.

Step 5 Mode S Reply Pulse Shape (Subparagraph 2.2.4.2.3 c)

Repeat the measurement for decay time.

==========

Frequency Spectrum of Mode S Replies

The significance of setting the transponder code to 7777 is not known. This appears to be a carry-over from an ATCRBS test where it would make sense to provide the maximum number of pulses. Although there is no negative effect, it is not necessary.

2.4.2.3.4 Frequency Spectrum of Mode S Replies (Subparagraph 2.2.4.2.3 d)

…

Measurement Procedure

Connect the equipment as shown in Figure 2-32. ~~Set the transponder to the 7777 identification code.~~ Interrogate the transponder with a standard Mode S surveillance-identity interrogation and observe the spectral response of the reply.

==========

Transponder Recovery and Desensitization

ATCRBS Single Pulse Desensitization and Recovery

The transponder is required to be desensitized by a pulse more than 0.7 microseconds in duration. Currently the test procedure allows using a desensitizing pulse equal to 0.7 microseconds. The test procedure should use a pulse greater than 0.7 microseconds in duration. Also, the test procedure sets the amplitude of the desensitizing pulse at the "standard level" that is –60 dBm. The problem with this is that a transponder can be within specification and already be recovered to full MTL by the first measurement point at 3 microseconds (-60 dBm + -9 dBm = -69 dBm immediate + -12dBm recovery = -81 dBm). The test should use a desensitizing pulse equal to 50 dB above MTL since the requirement specifies that the equipment shall recover to within 3 dB of MTL from a

desensitizing pulse equal to 50 dB above MTL after 15 microseconds. [THE PROPOSAL TO CHANGE THE 0.7 TO 0.8 WAS REJECTED]

2.3.2.6 Transponder Recovery and Desensitization (Paragraph 2.2.7)

Step 1 ATCRBS Single Pulse Desensitization and Recovery (Subparagraphs 2.2.7.1.1 and 2.2.7.2)

Connect the equipment as shown in Figure 2-27. Set the master test set to generate a single pulse not less than 0.~~7~~ 8 microsecond wide at the standard ATCRBS interrogation rate and a power level equal to 50 dB above MTL. Set the slave test set to generate an ATCRBS Mode A interrogation delayed 3 microseconds from the trailing edge of the single pulse. Determine the amplitude of the slave test set signal required to produce 90% reply efficiency. Repeat for master to slave test set delay of ~~10~~15 microseconds.

2.4.2.6 Transponder Recovery and Desensitization (Subparagraph 2.2.7)

…

Step 1 ATCRBS Single Pulse Desensitization and Recovery (Subparagraphs 2.2.7.1.1 and 2.2.7.2)

Connect the equipment as shown in Figure 2-27. Set the master test set to generate a single pulse not less than 0.~~7~~ 8 microsecond wide at the standard ATCRBS interrogation rate and a power level equal to 50 dB above MTL. Set the slave test set to generate an ATCRBS Mode A interrogation delayed three microseconds from the trailing edge of the single pulse. Determine the amplitude of the slave test set signal required to produce 90 percent reply efficiency. Repeat for master to slave test set delays of 6, 10 and 15 microseconds.

==========

Recovery from a Mode S Interrogation Requiring no reply

The test procedure does not set the interrogation level of the Mode S Interrogation or of the Mode A interrogation. Since the recovery requirement is a function of time and power level, the test procedure should set specific test conditions. The test procedure should set the Mode S interrogation level to -21 dBm, and position the Mode A interrogation delayed 45 microseconds relative to the sync-phase reversal of the Mode S.

2.3.2.6 Transponder Recovery and Desensitization (Paragraph 2.2.7)

…

Step 2 Recovery from a Mode S Interrogation Requiring No Reply (Subparagraph 2.2.7.2.1)

With the equipment connected as shown in Figure 2-27, set the master test set to generate a short Mode S surveillance interrogation with broadcast address. Set the slave test set to generate an ATCRBS Mode A interrogation at a power level equal to 3 dB above MTL. Measure the delay time between the master and the slave test sets necessary to elicit a reply efficiency of 90%.

2.4.2.6 Transponder Recovery and Desensitization (Subparagraph 2.2.7)

…

Step 2 Recovery from a Mode S Interrogation Requiring No Reply (Subparagraph 2.2.7.2.1)

With the equipment connected as shown in Figure 2-27, set the master test set to generate a short Mode S surveillance interrogation with broadcast address. Set the slave test set to generate an ATCRBS Mode A interrogation at a power level equal to 3 dB above MTL. Measure the delay time between the master and the slave test sets necessary to elicit a reply efficiency of 90 percent.

==========

Recovery from a Mode S Comm-C Interrogation

Step 3 in both 2.3.2.6 and 2.4.2.6 is a test of recovery from a Mode S Comm-C interrogation segment that does not require a reply. These tests reference subparagraph 2.2.7.2.2 as the requirement being tested. Subparagraph 2.2.7.2.2 is "not used".

Since these tests appear to reference a requirement that has been removed, it is recommended that these tests be deleted. (Note: Step 2 tests the recovery from a Mode S interrogation requiring no reply. This is a similar test) If the test step is deleted, subsequent test steps will need to be re-numbered accordingly. [DELETION OF THE TEST PROCEDURE IS REJECTED AFTER RECEIPT OF AN EXPLANATION OF THE CHANGE TO DELETE THE REQUIREMENT FROM VINCE ORLANDO. SC-209 AGREED TO KEEP THE TEST PROCEDURE AND CHANGE THE REFERENCE TO 2.2.7.2.1.]

2.3.2.6 Transponder Recovery and Desensitization (Paragraph 2.2.7)

…

~~Step 3 Recovery from a Mode S Comm-C Interrogation (Subparagraph 2.2.7.2.2)~~

~~With the equipment connected as shown in Figure 2-27, set the master test set to generate the initial segment of a properly addressed Comm-C interrogation at a signal level of -21 dBm. Set the slave test set to generate an ATCRBS Mode A inter rogation delayed 45 microseconds from the sync phase reversal of the master interrogation. Determine the amplitude of the slave test signal required to produce 90% reply efficiency.~~

…

2.4.2.6 Transponder Recovery and Desensitization (Subparagraph 2.2.7)

…

~~Step 3 Recovery from a Mode S Comm-C Interrogation (Subparagraph 2.2.7.2.2)~~

~~With equipment connected as shown in Figure 2-27, set the master test set to generate the initial segment of a properly addressed Comm-C interrogation at a signal level of -21~~

~~dBm. Set the slave test set to generate an ATCRBS Mode A interrogation delayed 45 microseconds from the sync phase reversal of the master interrogation. Determine the amplitude of the slave test signal required to produce 90 percent reply efficiency.~~

==========

Recovery from a suppression pair

Section 2.3.2.6 Step 4 tests the recovery from a suppression pulse pair. The title of the test step is incorrect. Also, the current test is adequate to verify that a suppression pair does not suppress a Mode S interrogation, but with the proposed change will better determine the recovery rate if the receiver was desensitized.

2.3.2.6 Transponder Recovery and Desensitization (Subparagraph 2.2.7)

…

Step 4 Recovery from a~~n ATCRBS or All-Call~~ Suppression ~~Pulse~~ Pair (Subparagraph 2.2.7.2.3)

With the equipment connected as shown in Figure 2-27, set the master test set to generate a P1-P2 pulse pair at the ATCRBS standard interrogation rate and a power level equal to -35 dBm. Set the slave test set to generate a Mode S-Only All-Call interrogation delayed 10 microseconds from the trailing edge of the P2 pulse of the master test set interrogation. Determine the amplitude of the slave test set signal required to produce 90%~~Measure the~~ reply efficiency.

The equivalent test in the detailed test procedures combines the recovery from a suppression pair with a test of the recovery from an unaccepted ATCRBS/Mode S or ATCRBS-Only All-Call. It is suggested that the recovery from a suppression pair test be modified to include the same changes as in step 4 of 2.3.2.6 for the reasons stated above.

Currently the test procedure only tests the recovery from the unaccepted ATCRBS/Mode S All-Call. It is suggested that the test procedure repeat the test using the ATCRBS-Only All-Calls in order to fully test the requirements. Also the test step should suggest that the Mode S-Only All-Call that is generated from the slave test set use an II code other than 0 when the lockout is activated, otherwise those replies will be locked out as well.

2.4.2.6 Transponder Recovery and Desensitization (Subparagraph 2.2.7)

…

Step 4 Recovery from a suppression pair or unaccepted ATCRBS/Mode S or ATCRBS-Only All-Calls (Subparagraphs 2.2.7.2.3 and 2.2.7.2.5)

With the equipment connected as shown in Figure 2-27, set the master test set to generate a P1-P2 pulse pair at the ATCRBS standard interrogation rate and a power level equal to -35 dBm. Set the slave test set to generate a Mode S-Only All-Call interrogation delayed 10 microseconds from the trailing edge of the P2 pulse of the master test set interrogation. Determine the amplitude of the slave test set signal required to produce 90%~~Measure the~~ reply efficiency.

Repeat the procedure with an ATCRBS-Only All-Call in place of the suppression pair. Set the Mode S-Only All-Call from the slave test set delayed 10 microseconds from the trailing edge of the P4 pulse of the master test set interrogation.

Lock out the transponder to All-Calls (non-selective) and repeat the procedure with P4-type All-Call interrogations in place of the suppression pair. Set the II field of the Mode S All-Call to a value other than 0 so that it will not be affected by the lock-out condition.

==========

The Narrow Pulse Performance test should be modified to be consistent with the modified Step 2 Single Pulse Desensitization and Recovery.

2.4.2.6 Transponder Recovery and Desensitization (Subparagraph 2.2.7)

…

Step 5 Narrow Pulse Performance (Subparagraphs 2.2.7.1.2)

With the equipment connected as shown in Figure 2-27, set the master test set to generate a single pulse less than 0.7 microsecond wide at the standard ATCRBS interrogation rate and a power level equal to 50 dB above MTL. Set the slave test set to generate an ATCRBS Mode A interrogation delayed three microseconds from the trailing edge of the single pulse. Determine the amplitude of the slave test set signal required to produce 90 percent reply efficiency. Repeat for master to slave test set delays of 6, 10 and 15 microseconds.

==========

Note: The following correction to the Dead Time test procedure and requirement has already been captured in SC209-WP01-05-DO-181D-v0-1.pdf.

Dead Time

The Dead Time test in 2.4.2.6 step 6 has an incorrect requirement reference. There is a missing section number in the associated requirements section. The requirement section number should be added and the reference in the test procedure corrected.

2.4.2.6 Transponder Recovery and Desensitization (Subparagraph 2.2.7)

…

Step 6 Dead Time (Subparagraph 2.2.7.~~3~~2.6)

…

2.2.7.2.5 Recovery From Unaccepted ATCRBS/Mode S and ATCRBS-Only All-Calls

Following unaccepted ATCRBS/Mode S or ATCRBS-Only All-Calls, the transponder shall recover sensitivity according to subparagraph 2.2.7.2.

2.2.7.2.6 Dead Time

The time interval beginning at the end of a reply transmission and ending when the receiver has regained its sensitivity to within 3 dB of MTL shall not exceed 125 microseconds.

Note: *Dead Time should be minimized to maximize system reliability.*

==========

Recovery from a Mode S Interrogation Which Has Not Been Accepted

The test procedure does not set the interrogation level of the Mode S Interrogation or of the Mode A interrogation. Since the recovery requirement is a function of time and power level, the test procedure should set specific test conditions. The test procedure should set the Mode S interrogation level to -21 dBm, and position the Mode A interrogation delayed 45 microseconds relative to the sync-phase reversal of the Mode S.

2.4.2.6 Transponder Recovery and Desensitization (Paragraph 2.2.7)

~~**2.3.2.6 Transponder Recovery and Desensitization (Paragraph 2.2.7)**~~

…

Step 7 Recovery From a Mode S Interrogation Which Has Not Been Accepted (Subparagraph 2.2.7.2.4)

Connect the equipment as shown in Figure 2-27. Set the master test set to generate a standard Mode S surveillance interrogation with an incorrect address. Set the slave test set to generate an ATCRBS/Mode A interrogation. Measure the delay time between the master and slave test sets necessary to elicit a reply efficiency of 90 percent.

==========

Low Level Asynchronous Interference

In subparagraph 2.2.8.1 the required response to Low Level Asynchronous Interference is defined over a range of signal levels between -65 and -21 dBm. Currently the test procedure only uses -50 dBm for the Mode S interrogation. The test procedure should be expanded to include the defined range.

2.4.2.7 Response to Interference

…

Step 1 Low Level Asynchronous Interference (Subparagraph 2.2.8.1)

Insert a 0.8 microsecond wide pulse [defined in paragraph 2.4.1 i (11)] with amplitude 12 dB below P1 of the standard Mode S-Only All Call at a repetition rate of 10,000 Hz. Measure Reply Ratio. Repeat the test for all signal levels between -65 and -21 dBm in ~~5~~1-dB increments.

[SC-209 AGREED TO ALLOW GARY TO REVIEW THE TEST PROCEDURES IN ORDER TO IDENTIFY THOSE PLACES WHERE THE 5-DB STEPS ARE LOCATED AND CHANGE THEM TO ONE (1) DB INCREMENTS]

==========

DME and JTIDS Interference Tests

In subparagraph 2.2.8.4 the required response to TACAN/DME and JTIDS Interference is defined over a range of signal levels between -68 and -21 dBm. Currently the test procedure only uses -50 dBm for the Mode S interrogation. The test procedure should be expanded to include the defined range. Also, the test calls for a 6.4 microsecond wide pulse pair when it should call for a single pulse. [NEED FURTHER ANALYSIS ON THE AMOUNT OF TESTING INVOLVED BEFORE THE CHANGES BELOW CAN BE ACCEPTED. WILL BE REVISITED AFTER REPORT FROM THE MANUFACTURERS.]

2.4.2.7 Response to Interference

…

Step 4 DME and JTIDS Interference Tests (Subparagraph 2.2.8.4)

Insert 3.5-microsecond wide pulse pairs spaced 12 microseconds apart with amplitudes of -30 dBm at a rate of 3,600 randomly spaced pulse pairs per second. Observe the reply ratio as the frequency of the interfering signal is varied over the ranges of 962 to 1020 MHz and 1041 to 1213 MHz in 1-MHz steps. Repeat the test for all signal levels between -68 and -21 dBm in ~~5~~1-dB increments.

Repeat the test using 3.5-microsecond wide pulse pairs spaced 30 microseconds apart.

Repeat the test using a single 6.4-microsecond wide pulse ~~pairs~~ at a random rate of 2000 pulses per second, with an amplitude of -80 dBm and a frequency of 1030 MHz.

==========

Self Test

There is a typographical error in the Self Test requirements section.

2.2.10.1 Self Test

If a self-test feature or monitor is provided as part of the equipment:

a. The device that radiates test interrogation signals or prevents transponder reply to proper interrogation during the test period shall be limited to intermittent use ~~is~~ for no longer than that required to determine the transponder status. …

Variable Direct Data

There is an incorrect requirement reference in 2.4.2.12.2 Step 5.

2.4.2.12.2 Variable Direct Data (Subparagraph 2.2.13.1.2)

…

Step 5 Flight Status and Vertical Status (Subparagraph~~s~~ 2.2.13.1.2 c)

…

Interrogate with formats UF=4, 5, 20, 21 and verify that the transponder follows the protocol of subparagraph ~~2.2.16.2.1~~2.2.14.4.9, and Figure 2-13.